Managing Growth: Sustainable Mobility

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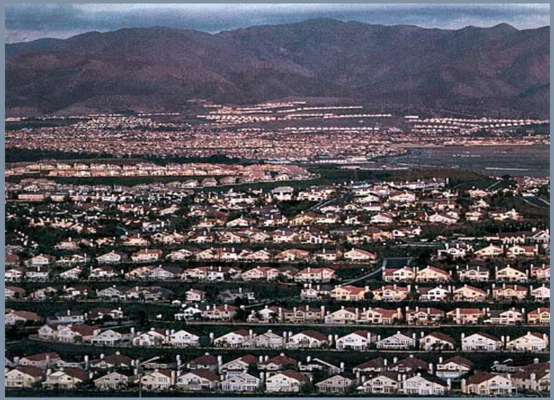
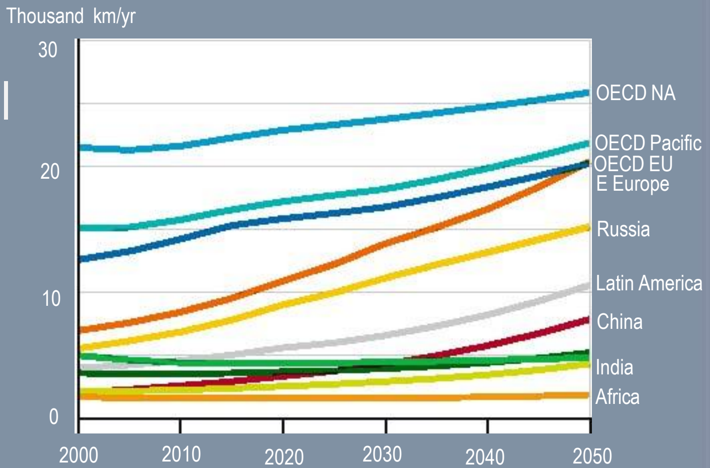
The Genie of Personal Mobility



- As described by Professor Garel Rhys, Cardiff Business School; the genie of personal mobility – “once society has discovered personal mobility rather than mass transit there is no way to get the genie back into the bottle”
- In Europe and US, private car ownership entered the culture in the 1950’s and in many ways the development of urban US cities have been shaped by the car
- Personal mobility is growing rapidly in countries such as India and China and is a globally recognised aspirational goal
- Conclusion – global vehicle populations will continue to rise rapidly, especially in developing countries with increasing spending power among the middle classes



Source : WBCSD : Mobility for Development

The challenge is to make this growth sustainable, both locally and globally

Sustainable Mobility

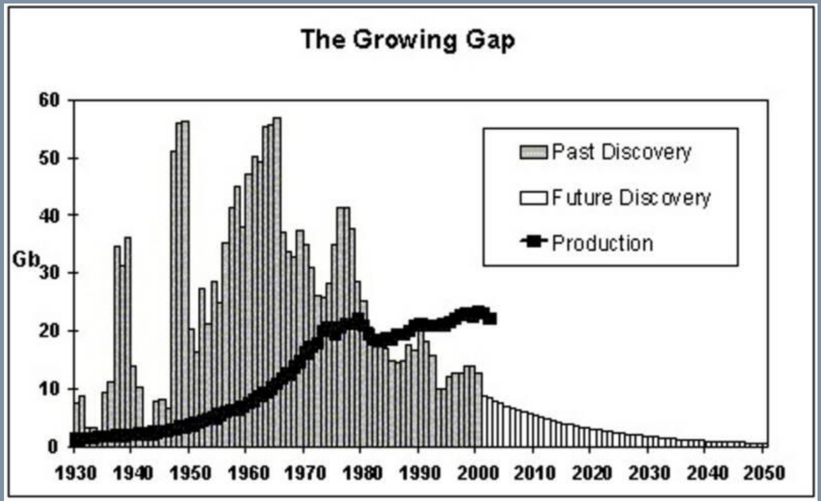
- The World Business Council for Sustainable Development (WBCSD) has defined sustainable mobility as:

  “*the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future*”.

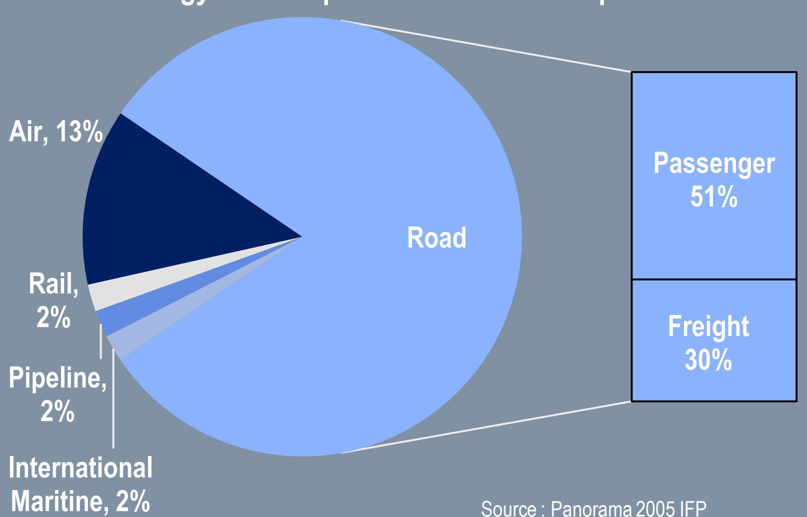
- The key sustainability challenges we face are:

Sustainability Issue	Local Challenge	Global Challenge
Energy Supply		✓
Environmental Impact	✓ Smog / air quality	✓ GHG
Road User Safety	✓	
Urban Congestion	✓	

The Transportation Low Carbon Challenge



- Long term consumption of oil based fuels is not sustainable and increasingly will not be economically viable
- Energy will cost a great deal more in the future and it will come from more diverse sources.



Source : Panorama 2005 IFP

- Transportation is responsible for circa 50% of global oil consumption
- Road based transport dominates the transportation sector
- Demands to reduce carbon consumption from consumer pressure (environmental and price pressures) and legislation

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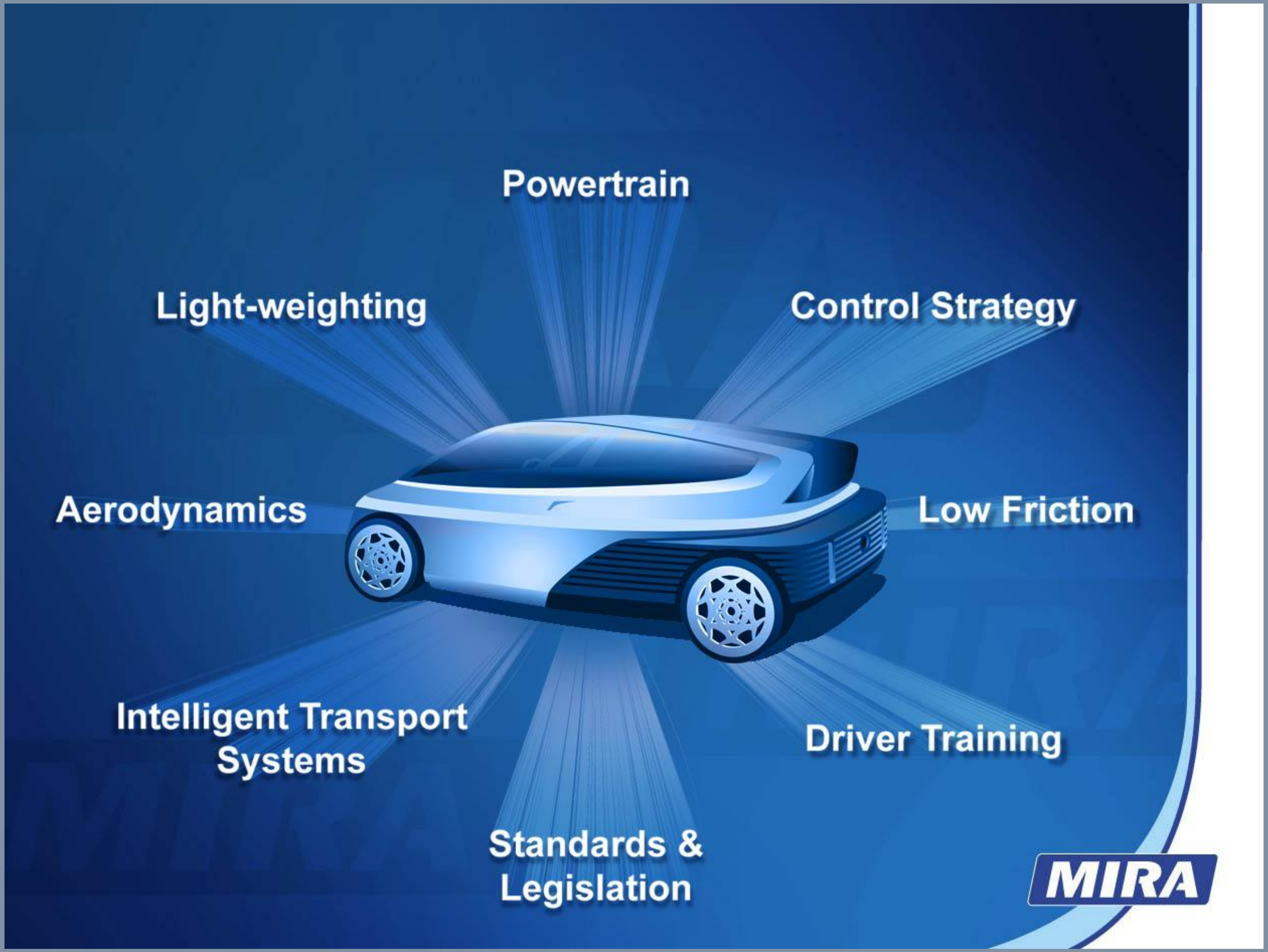
MIRA’s Holistic Approach to Sustainable Mobility



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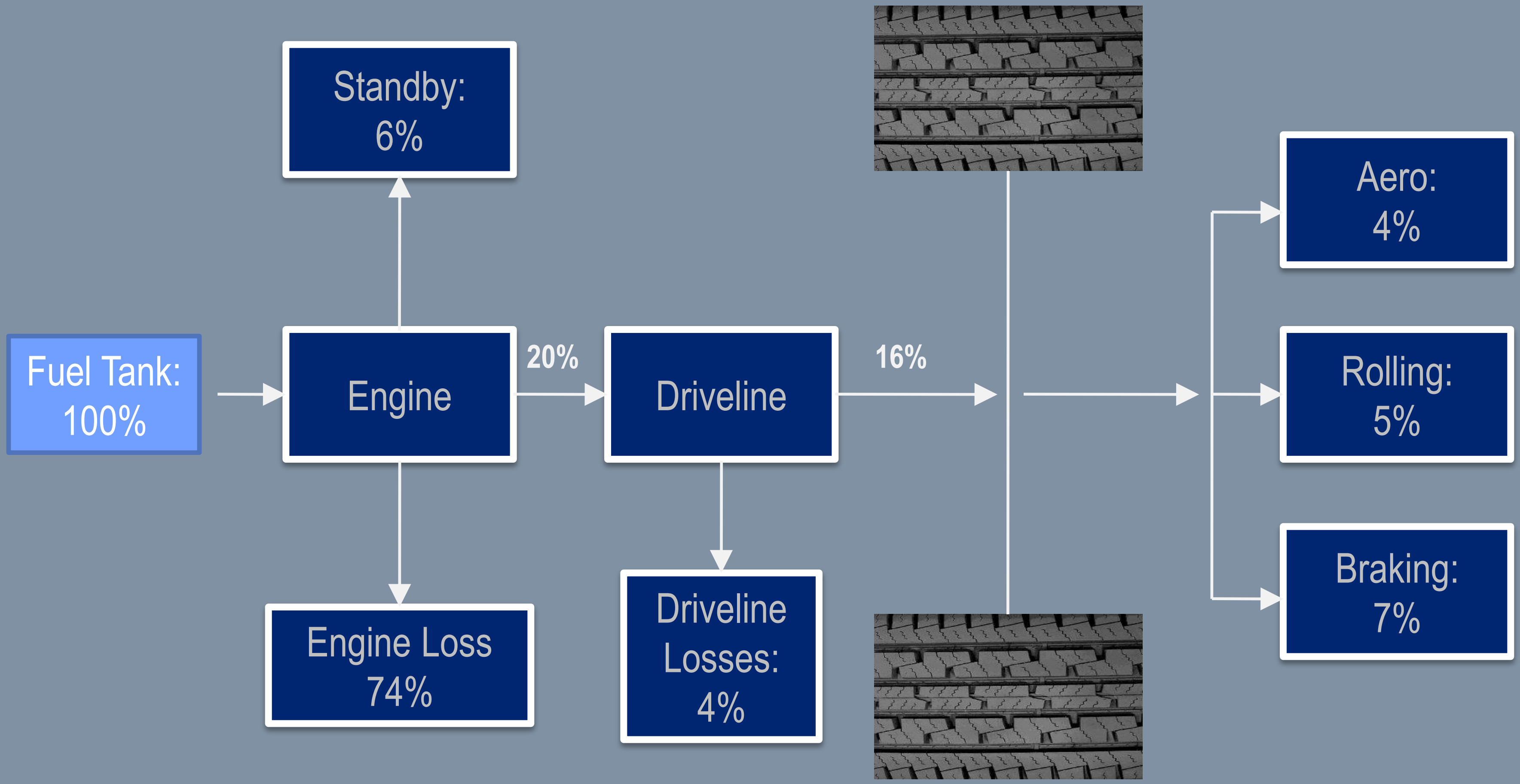
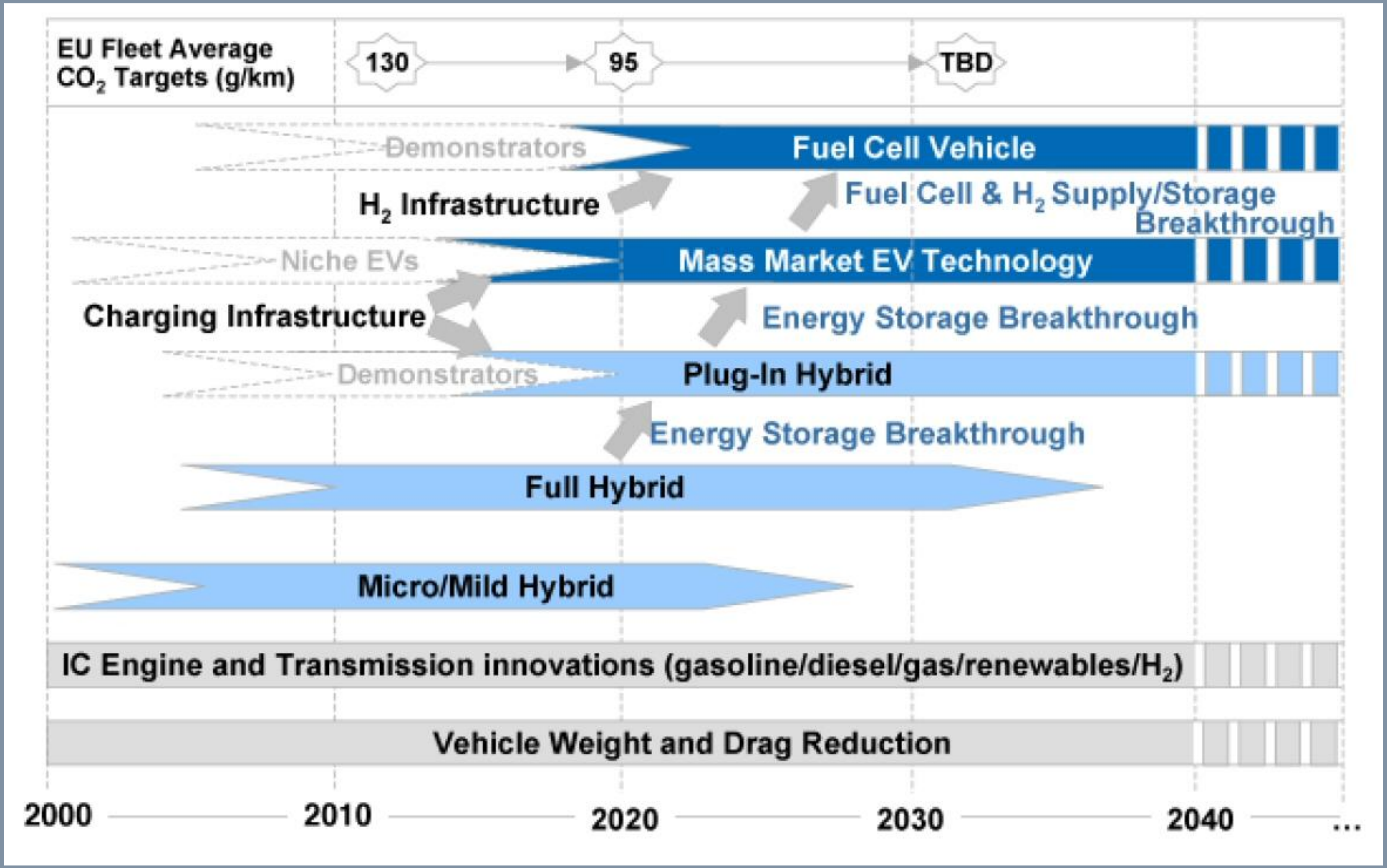
Overall energy balance in a typical Passenger Car



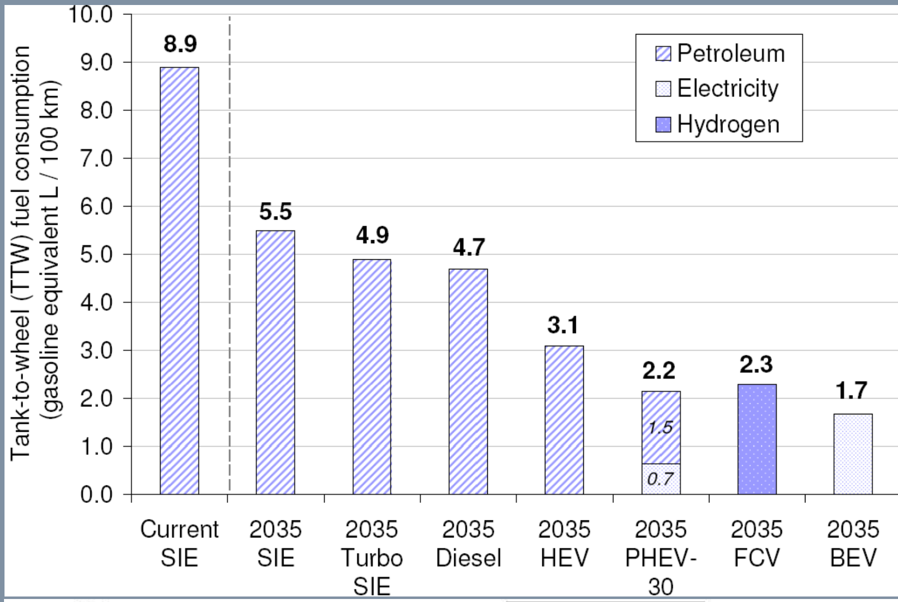
- Powertrain offers the biggest potential for reduction in energy consumption but all losses must be considered and optimised.

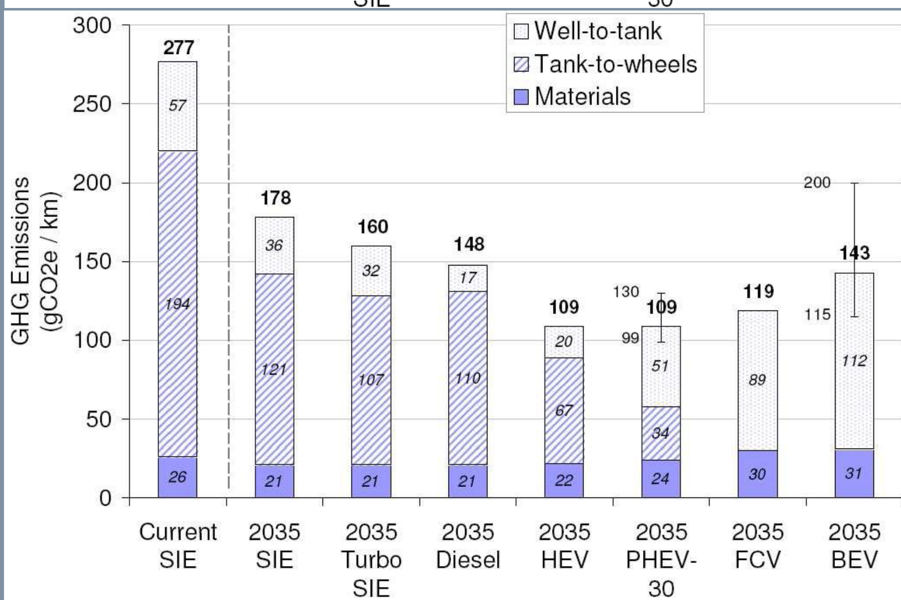
A Holistic Approach to Sustainable Mobility

The UK NAIGT Low Carbon Roadmap



TTW and GHG potential from alternative solutions





- EV variants offer the best potential for minimizing CO_2 in the longer term
- CO_2 emissions from PHEV will depend on the electricity generating mix
- Overall WTW GHG impact is not the same as TTW CO_2 performance
- Technology cost is an additional key factor
- Turbo SI and Diesel are most cost competitive.

On The road in 2035 http://web.mit.edu/sloan-auto-lab/research/beforeh2/otr2035/

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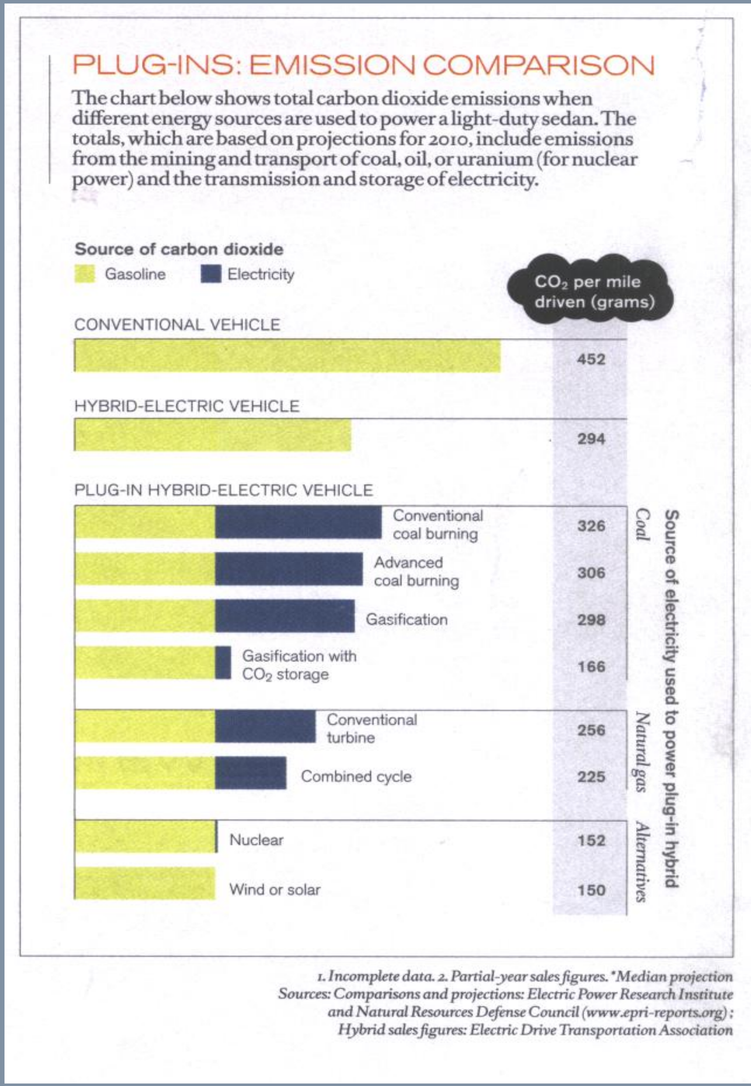
Low carbon source of electrical energy is integral to low CO_2 Vehicles



- Generating electricity from fossil based carbon yields virtually no overall WTW benefit for PHEVs
- Real impact requires non carbon based generation such as nuclear but that brings other issues
- Generating CO_2 at a single static source rather than multiple mobile sources provides opportunities to control CO_2 emissions.

Meeting the Transportation Low Carbon Challenge

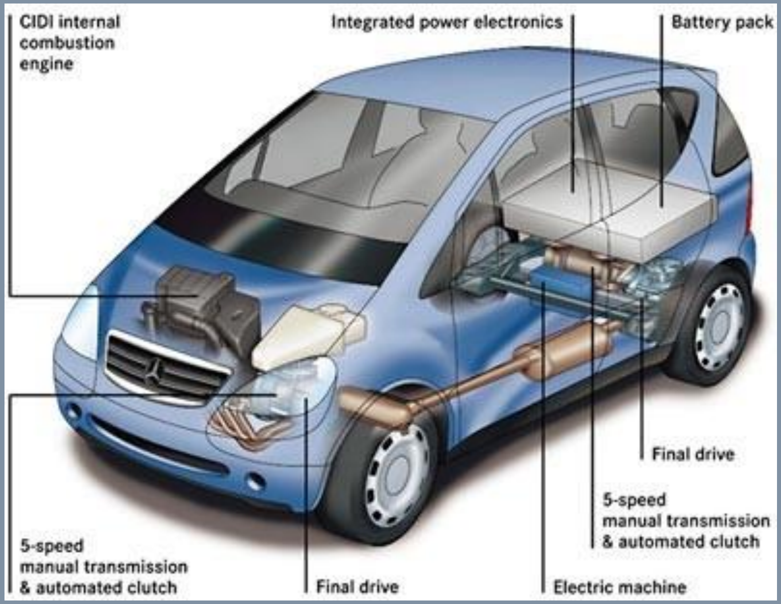
- Meeting the short and medium term challenge of making a significant reduction in carbon consumption requires "<u>the pragmatic application of known commercially viable technologies to mass market vehicles</u>"

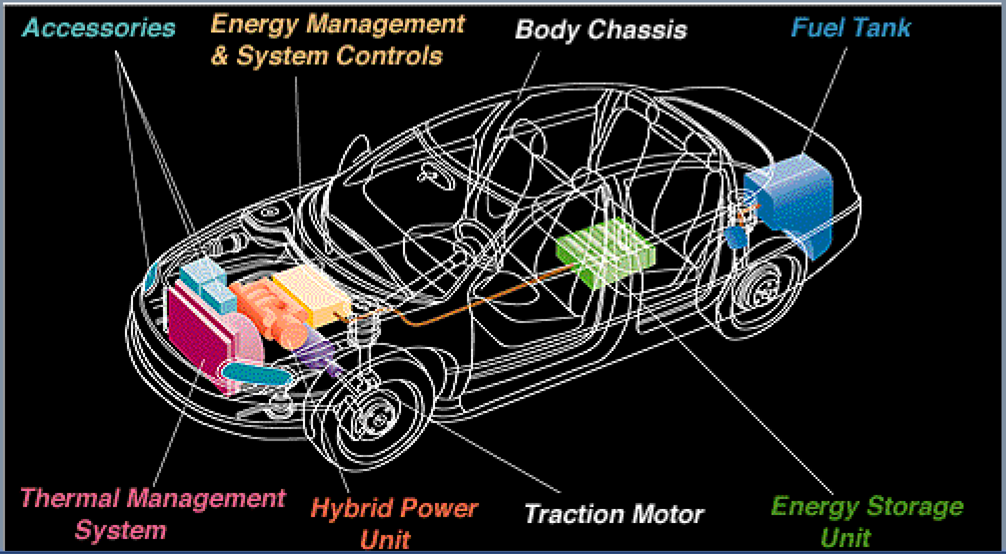
- To achieve significant reductions in transportation carbon consumption will require high volume sales of lower consumption vehicles rather than low volume sales of ultra low consumption vehicles:

  - commercial viability for vehicle manufacturers
  - consumer acceptance of the cost / benefit balance

HEV/PHEV Design Opportunities

- Repackaging the primary energy converter (smaller IC engine, EV driveline) brings opportunities for improved:
  - Aerodynamic drag (form drag & cooling drag)
  - Crashworthiness
  - Pedestrian protection
  - Weight distribution
  - Refinement.





Recent Case Study – Limo Green: Jaguar XJ351 REEV (Range Extended Electric Vehicle)

- Limo Green Hybrid Jaguar XJ
- TSB Funded research programme
- Series Hybrid with challenging performance, emissions and economy targets
  - Max Speed: 180 km/h
  - 0 – 100 km/h: 7.9 seconds
  - 1000 km range
  - 50km range EV, zero emissions mode
  - ~120g/km CO_2
- MIRA responsibilities include
  - Hybrid control system and powertrain integration
  - Prototype build and technology demonstration
- Current status
  - Running advanced prototype demonstrator
  - Final demonstrator variants under build

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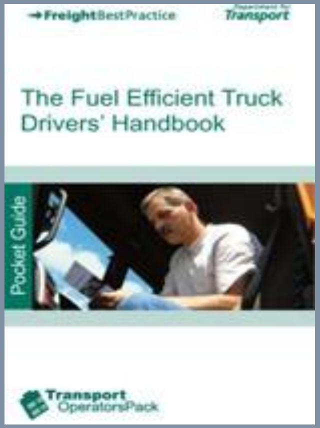
Driver Training

- Educating consumers to eco-drive can improve actual fuel efficiency by an average of 17 percent, although it varies from driver to driver; implemented on a mass scale, eco-driving could reduce emissions by about 3 percent globally. *(McKinsey report " Roads toward a low-carbon future: Reducing CO^2 emissions from passenger vehicles in the global road transportation system", Mar 2009)*

- This is a attainable today without vehicle modifications

- The UK Government has specifically targeted driver training in their ACT ON CO2 campaign

- Next generation driver aids will target economic driving behaviours
  - Foot-LITE - driver information system
  - Aims include encouraging greener driving.



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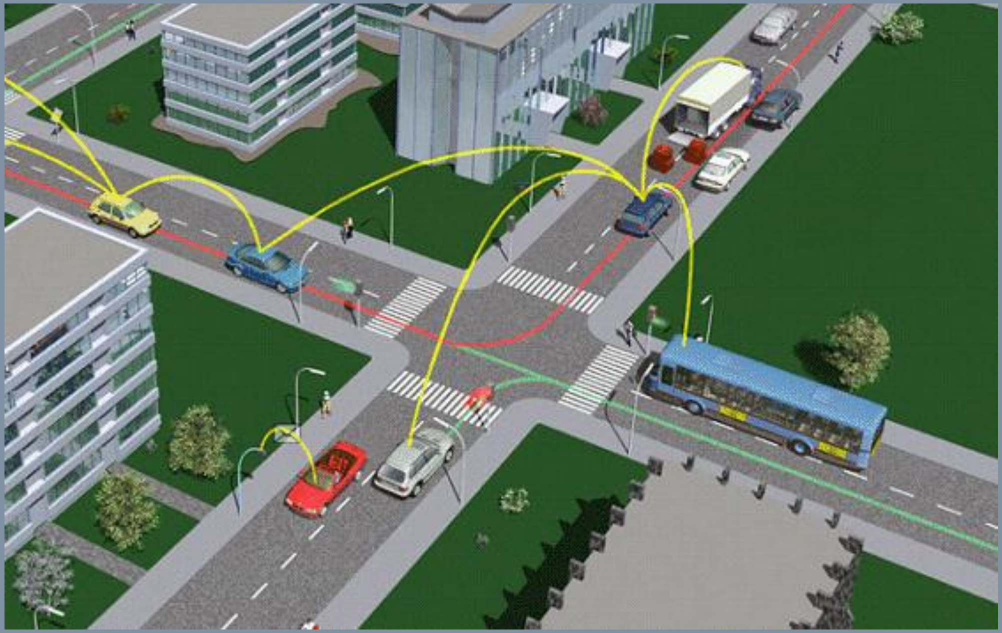
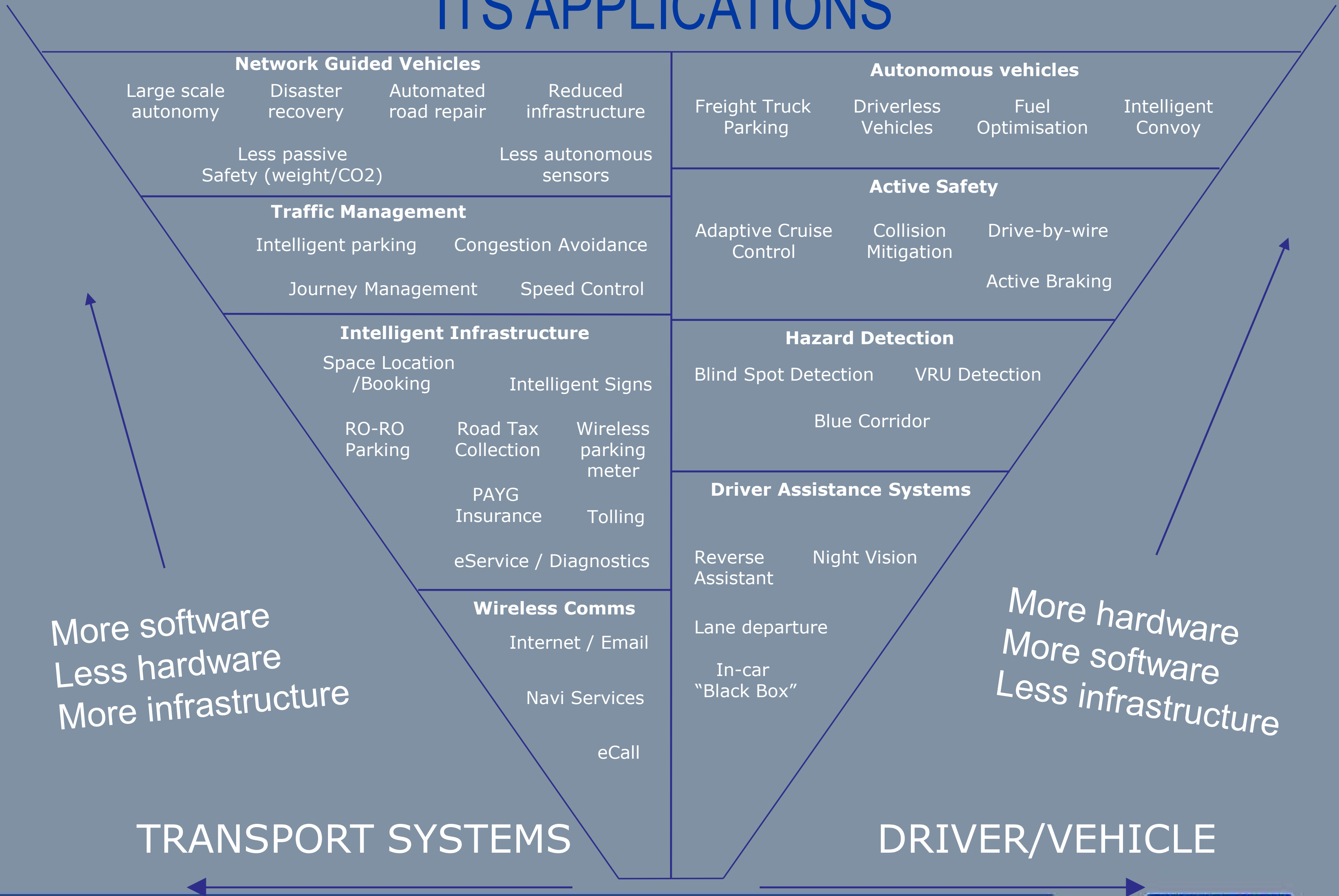
Intelligent Transport Systems

- Driver assistance
  - Autonomous Intelligent Cruise Control (platooning)
  - Road Traffic Accident information
  - Intelligent Speed Adaptation
  - Collision Avoidance



- Traffic management
  - Green Wave traffic lights
  - Variable speed limits
  - Road congestion charging
- Intelligent highway
  - Communication between vehicles and infrastructure
  - Vehicle response adapted by external influence
  - Adaptive zoned control.

ITS APPLICATIONS



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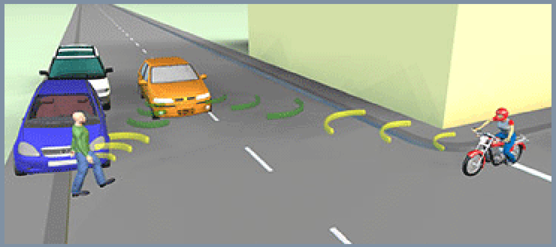
ITS addresses all of the sustainability challenges

Sustainability Issue	ITS Capability
Energy Supply	Increasing journey efficiency - Informed eco-drivers, reduced congestion, platooning, etc
Environmental Impact	Increasing journey efficiency - Informed eco-drivers, reduced congestion, platooning, etc
Road User Safety	Active safety – pre-crash management, vulnerable road user protection, Network Assisted Vehicles
Urban Congestion	Traffic Management – Green Wave, Network Assisted Vehicles,

Source: EU Project FOOT-LITE

Source: EU Project WATCHOVER



Source: EU Project SAFESPOT

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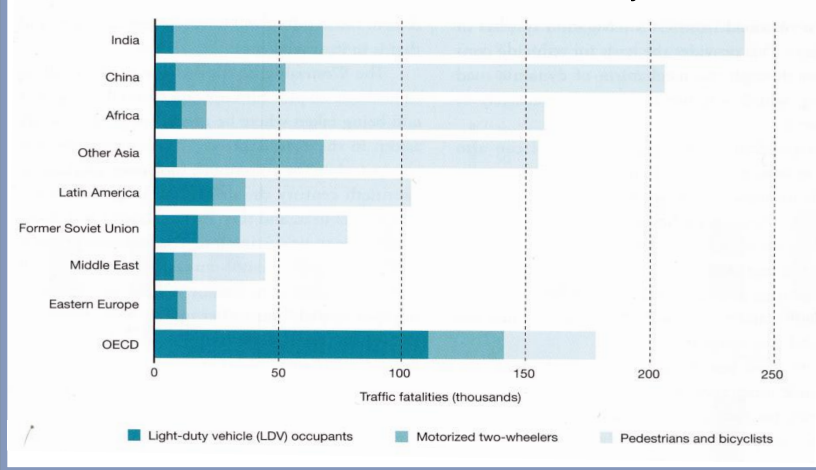
ITS potential for Improving Road User Safety

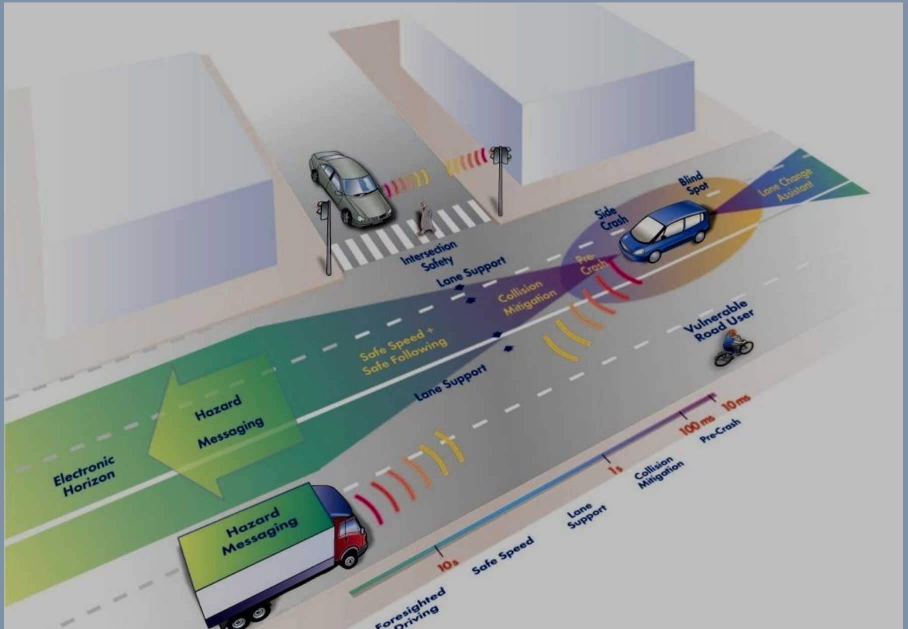
Source: Mobility 2030 WBCSD



Road Related Deaths, 2000

- EU, USA and Japan all have objectives to reduce road deaths by 50% over a decade
- Many vehicle manufacturers are seeking to go further – “zero”
- India has a particular challenge related to pedestrians and bicyclists

- ITS aims to prevent road accidents by developing a safety margin to detect dangerous situations and extend driver awareness pre-crash
- Example - Motorcycle Advanced Rider Assistance Systems (ARAS) including
  - Speed Alert, Curve Warning, Frontal Collision Warning, Intersection & Lane Change Support



Source: PReVENT Project

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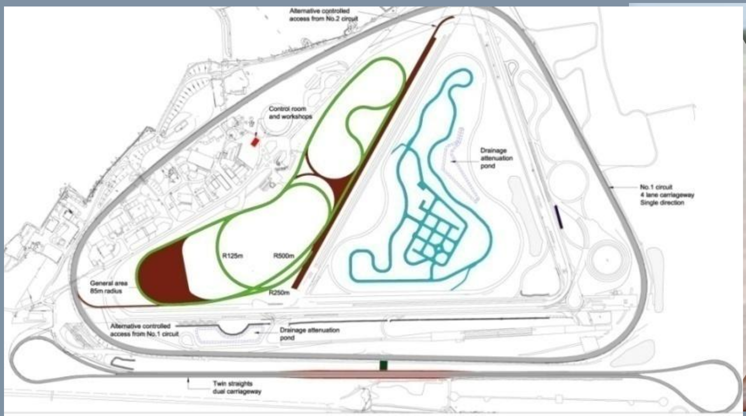
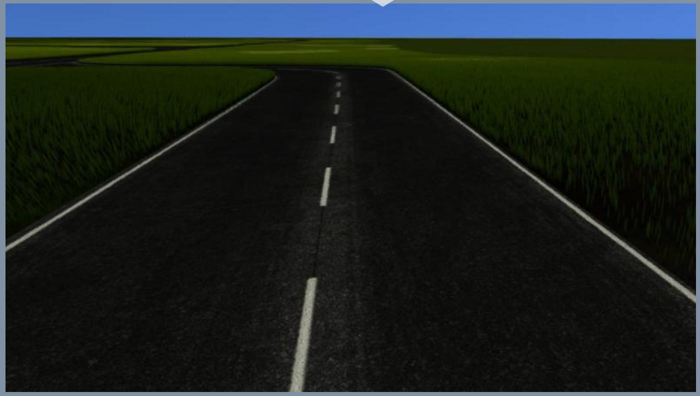
ITS potential for Low Carbon transportation

- Improving traffic flow through smarter traffic signals and other related approaches would improve the real world fuel efficiency of vehicles by:
    - reducing the number of starts and stops
    - reducing the need for acceleration and deceleration
    - increasing the average speed

- Policymakers in many regions generally overlook traffic flow and driving behavior as levers for CO_2 abatement
- Analysis suggests these are among the most cost-effective levers.
- Improving traffic flow and driving behavior yield a per-tonne CO_2 abatement benefit to society that is greater than the average benefit from fuel-efficiency measures
- A number of these measures could be achieved in relative short order, making them especially attractive for the period from 2010 to 2020.
- In developing cities and transport infrastructures, ITS can be introduced much more efficiently

Case Study: The InnovITS ADVANCE facility will enable MIRA and TRL to become leading global authorities on ITS





- Built in conjunction with our partners (TRL, InnovITS)
  - Phase 1a civil engineering completed (July 2010)
  - Phase 1b ITS systems installation underway (Feb 2011)
- Provides a safe, comprehensive and fully controllable 'cityscape' test track for development and validation of new ITS innovations
- Offers real time vehicle monitoring, modern communication technologies, private GSM and cellular networks that are fully configurable, state of the art V2V communication

The InnovITS ADVANCE facility enables simulation of the real ITS user scenarios

- Typical activities include
  - Advanced Driver assistance systems
  - Co-operative active safety
  - Driver behaviour studies
  - Tunnel exit/entrance simulation
  - Urban canyon simulation
  - Telecoms access and denial
  - Intelligent parking
  - V2V and V2I communication
  - Road sign detection
  - Urban traffic management
  - Intersection safety systems
  - Collision avoidance
  - Blind Spot detection
  - Advanced navigation services

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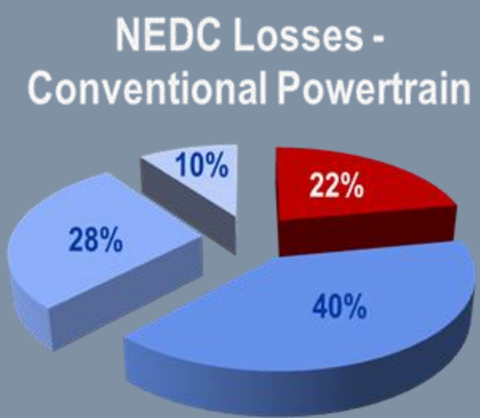
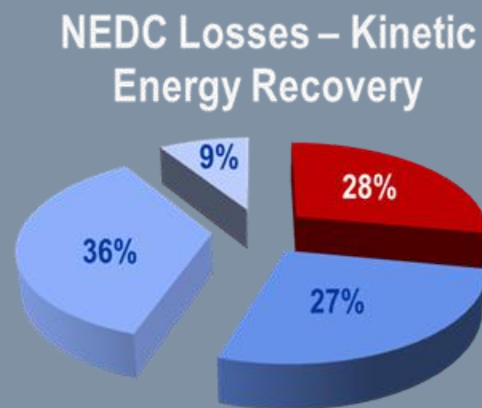
Aerodynamics - Parasitic Losses

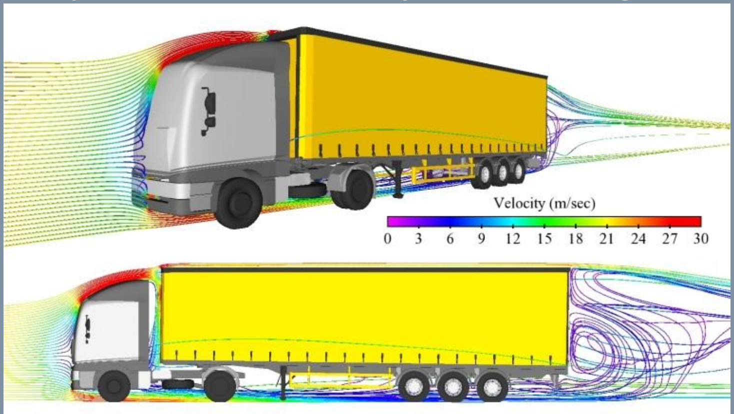


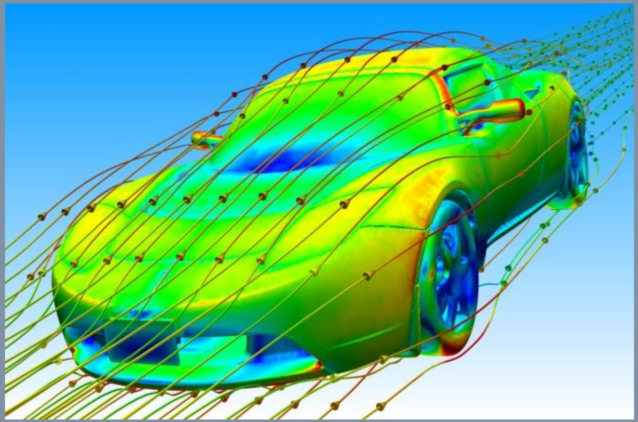


- The average speed on the NEDC cycle is just 33kph
- Even so aerodynamics is more than a quarter of the losses on a vehicle with a kinetic energy recovery system
- At more realistic customer vehicle speeds of 80-90kph aerodynamics comprises approximately half of the parasitic losses

Aerodynamics Development

- Aerodynamics is a ‘low cost’ alternative to expensive powertrain and light-weighting developments, a closer cooperation between styling and aerodynamics yields zero-cost improvements in drag, and hence fuel economy / CO_2 emissions
- Many major OEMs are now targeting drag coefficients of 0.21, a 30-40% reduction over current vehicles, potentially yielding CO_2 reductions of 10-20%
- Example 1 - aerodynamic development of a Heavy Goods Vehicle yielded drag improvements of 17% resulting in a 9-13% reduction in fuel consumption





- Example 2
  Development of the Tesla Roadster reduced drag by 11% substantially increasing this EV’s range

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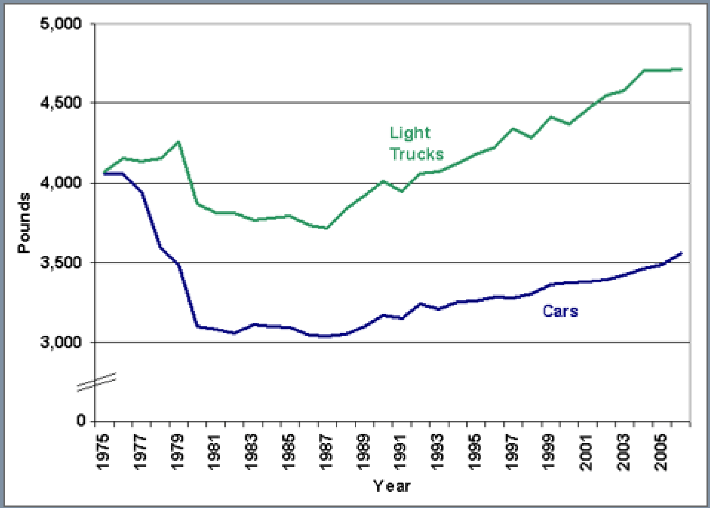
Light Weighting



As vehicles and markets mature (including incremental legislation) vehicle weight has crept up over the past 30 years

The three strategies to reduce weight are:

- lightweight material substitution
- vehicle design changes
- vehicle downsizing.

Every 10% of weight reduced from the average new car or light truck can cut fuel consumption by around 7%.

With aggressive material substitution, up to 20% of vehicle weight can be cut.

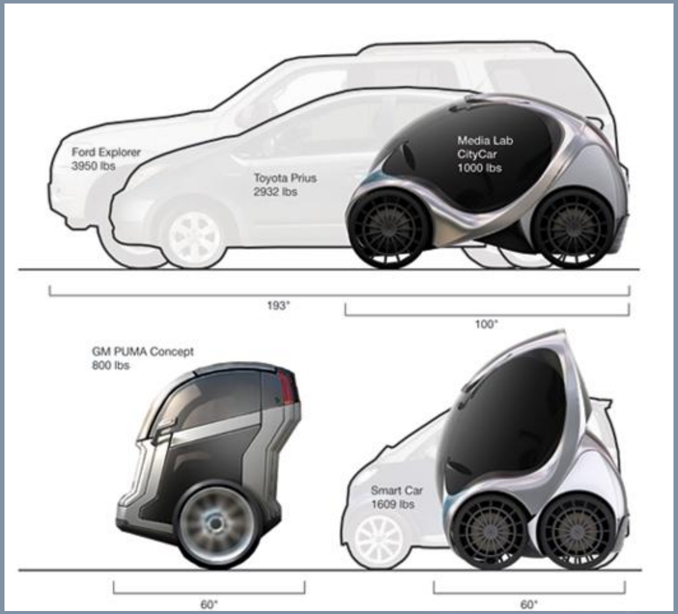
If a buyer selected a small car instead of a midsize, or a midsize instead of a large car, the vehicle's weight could be reduced by 9% to 12%. For SUVs, minivans and pickups, the weight savings can reach 26%.

Based on these assessments of material substitution, vehicle redesign, and downsizing, weight reduction of 20-35% is possible by 2035.

On The road in 2035 http://web.mit.edu/sloan-auto-lab/research/beforeh2/otr2035/

Meeting the Transportation Sustainability Challenge

- Meeting the short and medium term challenge of making a significant improvement in sustainable transportation requires "*the pragmatic application of known commercially viable technologies to mass market vehicles and proven ITS traffic management strategies in urban environments*"



- Meeting the long term challenge of sustainable personal mobility and road based transport requires "*a holistic approach to vehicle design, road transport and our view of personal mobility*".

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Thank You

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